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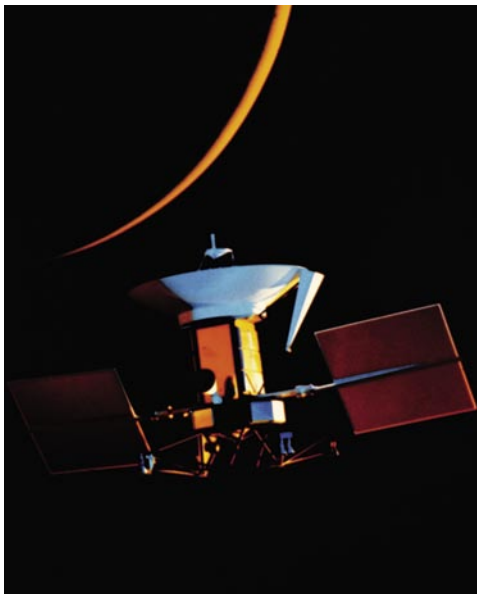
GPS Receiver Determines Attitude Rate

...with low noise, low cost, low weight, and higher accuracy



NASA Goddard Space Flight Center invites companies to license a new method for low-noise attitude rate determination that uses Global Positioning System (GPS) signals and eliminates the need for heavy and expensive gyroscopes and star trackers. By using the Doppler effect differences among GPS signals, this technology can calculate highly accurate attitude rates. It offers a low-noise, lightweight, and lower cost method for determining attitude rate for satellites and potentially for aviation and marine vehicles.

Benefits

- **Increases accuracy**: This GPS receiver determines attitude rate with both low noise and a 1- to 2-order-of-magnitude improvement in estimates of attitude rates for satellites and potentially other aerospace or marine vehicles.
- **Reduces weight**: By eliminating the need for gyroscopes or star trackers, this technology has the potential to significantly reduce weight as well as enable navigation control by a single GPS receiver.
- **Lowers cost**: Because gyroscopes and star trackers are extremely expensive, this technology can result in a major reduction in cost.

Applications

This technology may enable navigation control by a single GPS receiver for:

- Satellites
- Aviation
- Maritime

Technology Details

Attitude rate is how rapidly a satellite's attitude is changing and is instrumental in controlling the satellite. Current satellite technologies use star trackers to determine their orientation and use rate gyroscopes to determine the rate of change in their orientation. The satellite uses a controller to compare its current position with its desired position and makes adjustments accordingly based on this signal relationship. To eliminate noise produced by this method, a low-pass filter is used to extract useful data. This also limits the high-frequency rates the system can handle and limits its accuracy to ±2–3 degrees per second.

Currently, GPS receivers can provide time, orientation, speed, and attitude data. Because this new technology enables the GPS receiver to also provide attitude rate, a satellite can be totally controlled by the GPS receiver.

How it works

This patented NASA technology uses the Doppler effect to determine attitude rate. The Doppler effect is the shift in frequency of an electromagnetic or sound wave due to the relative motion of the source or the observer. There is a change in the wavelength of energy produced by an object that is caused by the object's motion towards or away from the observer (in this case, the GPS receiver).

This GPS receiver technology involves multiple antennae affixed to a satellite (or other body). Each antenna receives the same signal from GPS satellites, but those signals are slightly phase-shifted due to the physical separation of the antennae. As the antennae rotate around the receiver centroid, there is a shift in frequency due to the Doppler effect. This low-frequency term is mathematically related to the rotation of the antennae around the common centroid. Attitude rate can be determined by passing the signals through a multiplier.

Why it is better

This GPS receiver technology can very accurately determine attitude rate using both high and low frequencies, significantly lowering noise, weight, and cost. This method can yield a 1- to 2-order-of-magnitude improvement in estimates of attitude rates for satellites and potentially other aerospace or marine vehicles.

Current GPS devices estimate attitude rates using a phase-locked loop process, which is very noisy and requires data to go through a low-pass filter in order to be meaningful. This filtering, however, limits high frequency rates that the system can handle.

Other position-determining devices, such as gyroscopes or star trackers, use numerical differentiation to determine attitude rate. While accurate, they are also heavy, costly, and produce high noise.

Licensing and Partnering Opportunities:

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing this new GPS receiver (GSC-14087-1) technology for commercial applications.

For More Information

If you are interested in more information or want to pursue transfer of this technology (GSC-14087-1), please contact:

Office of Technology Transfer
NASA Goddard Space Flight Center
techtransfer@gsfc.nasa.gov

More information about working with NASA Goddard's Office of Technology Transfer is available online:
http://techtransfer.gsfc.nasa.gov

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